SWQMP Appendix V

Water Quality and Biological Sampling Procedures

Water Quality and Biological Sampling Procedures

Lexington, Kentucky

for

Lexington-Fayette Urban County Government

March 15, 2007

Table of Contents

Page

SAMPLING SITE DESCRIPTIONS

STREAMS

CR-S3 This site is in Scott County near US 25 and a church. Cane Run feeds the Royal Springs Aquifer which supplies Georgetown's drinking water. The site drains 32.1 square miles.

EH-S7 This site is on Andover Creek outside EA2. Access to the sampling site is via the golf cart path that intersects Andover Village Drive. This site drains 1.6 square miles.

NE-S4 This site is on North Elkhorn Creek at Russell Cave Road and drains 57 square miles.

SE-S1 This site is on South Elkhorn Creek at Parkers Mill Road near the airport. The drainage area is 21.8 square miles.

TB-S1 This site is 0.1 mile upstream of LFUCG's Town Branch Wastewater Treatment Plant (WWTP) and drains 5.3 square miles.

TB-S2 This site is upstream of the confluence with Wolf Run and approximately 1.7 miles downstream from the WWTP. This site has a drainage area of 8.9 square miles.

TB-S3 This site is further downstream at Darby Dan Farm near Bracktown. The drainage area is 25.3 square miles.

WH-S0 This site is at Veterans Park and is the furthest upstream site on West Hickman. The drainage area is 15.1 square miles.

WR-S1 This site runs parallel to Village Drive in a residential area and drains approximately 7.5 square miles.

WR-S2 This site is near the bridge at Old Frankfort Pike just upstream of the confluence with Town Branch. The drainage area is 10.4 square miles.

PROTOCOL - STREAM/FISH

1.0 What

As part of the LFUCG's Stormwater Quality Management Program, Tetra Tech, Inc. (Tt) will collect biological information on the resident fish community from streams found within and around Fayette County.

2.0 Why

The data collected from the fish survey will be analyzed using the Index of Biotic Integrity (IBI) (Karr 1981, Karr *et al.* 1986). The IBI assesses a stream's biological integrity by examining information about species richness and composition, trophic composition, fish abundance, and overall fish condition. The IBI summarizes the effects of all classes of factors (water quality, habitat quality, energy sources, flow regimes, and biotic interactions) influencing fish communities.

3.0 When

Fish sampling will be conducted once per year during late summer or early fall.

4.0 Where

Ten stations will be surveyed. For the purposes of the fish surveys, each station will be approximately 200 m in length or a distance ten times greater than the average bankfull stream (whichever is greater). The locations of the fish sampling areas are as follows:

CR-S3	EH-S7	NE-S4	TB-S1
TB-S2	TB-S3	SE-S1	WH-S0
WR-S1	WR-S2		

5.0 Who

The sampling crew will consist of biologists from Third Rock Consultants, LLC (TRC). Sampling will be coordinated by Jennifer Arnold (Tt) and Gerry Fister (TRC).

6.0 How

All available habitats will be sampled, including at least two riffles, two runs, and two pools. Fish will be identified, recorded, and released unharmed. Fish will be examined for sores, lesions, fin damage, and skeletal anomalies, any of which will be recorded. Any fish of unknown identity will be preserved in a 10% buffered formalin solution for laboratory examination.

The following water quality parameters will be measured and recorded using Hanna and/or YSI water quality instruments each time fish sampling is completed: pH (standard units), dissolved oxygen (mg/L), temperature (ºC), and specific conductance (µS). The weather conditions will also be recorded.

The results of the fish surveys will be interpreted using the index of biological integrity (Karr 1981, Karr *et al.* 1986, Ohio EPA 1990, and KDOW 1993).

The *Index of Biotic Integrity* is an index that measures biotic integrity by using 12 structural, functional, and community condition characteristics of the fish community. Each metric has an assigned number rating of 5, 3, or 1 based on deviation from the expected occurrence at a relatively unimpacted site located in a similar geographical region. The sum of the 12 ratings is the overall score. The IBI increases with increasing or improving water quality, but it cannot detect subtle differences in small samples (less than 200 individuals). Classification for the IBI is provided below:

INDEX OF BIOTIC INTEGRITY SCORING CRITERIA
INTERIOR PLATEAU ECOREGION, HEADWATER SITES ($\leq$11mi^2)
KENTUCKY DIVISION OF WATER 1997

Category	**Metric**	**Scoring Criteria**		
		5	**3**	**1**
Species Richness and Composition	Species Richness	Varies w/ drainage area (KDOW 1997)		
	Darter/Sculpin Richness	Varies w/ drainage area (KDOW 1997)		
	# Headwater Species	> 1	1	0
	# Minnow Species	> 5	2 - 5	< 2
	Intolerant Richness	Varies w/ drainage area (KDOW 1997)		
	% Tolerant Species	< 20%	20 – 45%	> 45%
Trophic Composition	% Omnivores	< 40%	40 - 60%	> 60%
	% Insectivores	Varies w/ drainage area (KDOW 1997)		
	% Pioneer Species	< 30%	30 – 55%	> 55%
Fish Condition	# Simple Lithophiles	Varies w/ drainage area (KDOW 1997)		
	% DELT anomalies	< 0.1%	0.1 – 1.3%	> 1.3%
	# of Individuals	> 100	50 – 100	< 50

INDEX OF BIOTIC INTEGRITY SCORING CRITERIA
INTERIOR PLATEAU ECOREGION, WADING SITES (>11mi^2)
KENTUCKY DIVISION OF WATER 1997

Category	**Metric**	**Scoring Criteria**		
		5	**3**	**1**
Species Richness and Composition	Species Richness	Varies w/ drainage area (KDOW 1997)		
	Darter/Sculpin Richness	Varies w/ drainage area (KDOW 1997)		
	Sunfish Richness	> 2	2	< 2
	Sucker Richness	> 1	1	0
	Intolerant Richness	Varies w/ drainage area (KDOW 1997)		
	% Tolerant Species	< 20%	20 – 45%	> 45%
Trophic Composition	% Omnivores	< 25%	25 - 45%	> 45%
	% Insectivores	Varies w/ drainage area (KDOW 1997)		
	Top Carnivore Richness	> 1	1	0
Fish Condition	# Simple Lithophiles	Varies w/ drainage area (KDOW 1997)		
	% DELT anomalies	< 0.1%	0.1 – 1.3%	> 1.3%
	# of Individuals	> 100	50 – 100	< 50

CLASSIFICATION SCHEME FOR
INDEX OF BIOTIC INTEGRITY
KENTUCKY DIVISION OF WATER

IBI SCORE (Sum of 12 Metrics)	CLASSIFICATION SCHEME (BIOTIC INTEGRITY)	FISH COMMUNITY ATTRIBUTES
57 – 60	Excellent	Little human disturbance; all expected species present with most intolerant forms; full array of age classes; balanced trophic structure.
48 – 52	Good	Species richness less; fewer intolerants; some species less abundant than expected; trophic structure shows signs of stress.
39 – 44	Fair	Loss of intolerant forms, fewer species, skewed trophic structure (> omnivores or tolerant spp.); older age classes rare for top predators.
28 – 35	Poor	Omnivores, tolerants, habitat generalists dominate; few top carnivores, hybrids and diseased fish often present.
< 23	Very Poor	Few fish present, mostly introduced or tolerant forms; hybrids common; disease, parasites, fin damage, other anomalies regular.

PROTOCOL - STREAM/MACROINVERTEBRATES

1.0 What

As part of the LFUCG's Stormwater Quality Management Program, Tt will collect biological information on the resident macroinvertebrate community from streams found within and around Fayette County.

2.0 Why

Macroinvertebrates are aquatic insects and other invertebrates that serve as food for fish and other aquatic organisms. They have varying tolerances for water pollution; therefore, they are important indicators of overall water quality. They can be found under rocks, in riffle and pool areas, among leaf packs, within root wads, and along undercut banks.

3.0 When

Macroinvertebrate sampling will be conducted once per year during spring.

4.0 Where

Ten stations will be surveyed. The locations for macroinvertebrate sampling are as follows:

CR-S3	EH-S7	NE-S4	TB-S1
TB-S2	TB-S3	SE-S1	WH-S0
WR-S1	WR-S2		

5.0 Who

The sampling crew will consist of biologists from TRC. Sampling will be coordinated by Jennifer Arnold (Tt) and Gerry Fister (TRC).

6.0 How

The sampling protocol is a modification of the multihabitat method outlined by the Kentucky Division of Water (KDOW 1993). This method insures that all available habitat types are sampled and a standardized field effort is followed throughout the study. Collections from each habitat type will be combined to form one composite sample.

Two surber samples will be collected from riffle habitats (one fast riffle and one slower riffle). Sweep samples will be collected from undercut bank habitats using a triangular kicknet or D-frame net. Two Coarse Particulate Organic Matter (CPOM) samples (leaf packs) will be collected at each site. A visual search of rocks and logs from both pool and riffle areas will be conducted for 30 minutes. The collected organisms will be placed in one container and preserved in 95 percent ethanol. In the laboratory, a 100-organism random subsample will be collected using techniques outlined by Plafkin et. al. (1989). Organisms will be identified to the lowest possible taxonomic level.

The following water quality parameters will be measured and recorded using Hanna and YSI water quality instruments each time fish sampling is completed: pH (standard units), dissolved oxygen (mg/L), temperature (ºC), and specific conductance (µS). The weather conditions will also be recorded.

The results of the macroinvertebrates collections will be assessed using the following community metrics: Total Number of Individuals, Taxa Richness, Ephemeroptera-Plecoptera-Trichoptera (EPT) Richness, EPT Index, Percent EPT Individuals, Chironomidae Richness, Percent Chironomidae Taxa, Percent Contribution of Five Dominant Taxa (PCD_5), and Modified Hilssenhoff Biotic Index (MHBI) (see below). The Macroinvertebrate Bioassessment Index (MBI) (described below) will be used to summarize results of selected metrics and arrive at a water quality rating for each sampling station.

Total Number of Individuals. This is the total organism abundance in a sample. Values considerably above or below those observed at other stations could indicate impairment.

Taxa Richness. This refers to the total number of species or distinct taxa in the sample. Sampling stations represented by greater numbers of species than that found at other stations are generally considered to have better water quality and habitat conditions.

EPT Richness. This is the total number of species or taxa within the pollution-sensitive insect groups. Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). This number generally will increase with improving water quality and habitat conditions.

EPT Index (or % EPT Taxa). This is the percentage of the total taxa that are composed of EPT. This number generally will increase with improving water quality and habitat conditions.

Percent EPT Individuals. This is the relative abundance of EPT individuals within the sample. These numbers will generally increase with improving water quality and habitat conditions.

Modified Hilssenhoff Biotic Index (MHBI) (Lenat 1993). This index was developed to summarize the overall pollution tolerance of the benthic community (benthic refers to organisms living on the stream or river bottom as well as other surfaces). The MHBI was produced through modifications of organic pollution only. The MHBI produces a single value (ranging from 0 to 10) this is compared with the following table to determine a water quality rating.

MHBI VALUES AND WATER QUALITY RATINGS

MHBI Value	Water Quality Rating
< 5.25	Excellent
5.25 – 5.95	Good
5.96 – 6.67	Good-Fair
6.68 – 7.70	Fair
> 7.70	Poor

Typically, the higher the MHBI value, the higher the benthic community's pollution tolerance and the lower the water quality rating. In other words, as the MHBI value increases, water quality and habitat conditions are considered to deteriorate. The formula for the MHBI is as follows:

$$\text{MHBI} = \frac{\Sigma\, n_i \times t_i}{N}$$

where:
n_i = number of individuals within a taxon or species
t_i = tolerance value of the taxon or species
N = total number of organisms in the samples

Chironomidae Richness and Percent Chironomidae Taxa. Chironomidae Richness refers to the total number of species or taxa within the dipteran (fly) family Chironomidae (midges). Generally, members of this family are considered to be pollution-tolerant, so high numbers of

Chironomidae taxa relative to other taxa (Percent Chironomidae Taxa) can reflect environmental stress.

Percent Contribution of Dominant Taxa$_5$ (PCD$_5$). This metric is determined by adding the relative abundance percentages of the five most dominant taxa at each station. Communities highly dominated by a few taxa (PCD_5 > 80%) may reflect an impaired condition.

Macroinvertebrate Bioassessment Index (MBI). Results from the five core community metrics listed above, Taxa Richness, EPT Richness, % EPT Individuals, Modified Hilsenhoff Biotic Index, and Percent Contribution of Dominant Taxa$_5$, were used to calculate a Macroinvertebrate Bioassessment Index (MBI) score for each station (KDOW 1993). Metric results from each station were compared to scoring criteria (based on stream order) developed by the KDOW and given a numerical score ranging from one to five. The individual metric scores for each station were totaled to produce an MBI score (0-25) that corresponded to a water quality rating of Excellent, Good, Fair, Poor, or Very Poor. Scoring criteria developed by the KDOW for each metric and the MBI water quality rating scheme are provided below.

MACROINVERTEBRATE BIOASSESSMENT INDEX (MBI) SCORING CRITERIA AND WATER QUALITY RATINGS – INTERIOR PLATEAU ECOREGION

Metric criteria derived from percentiles of first and second order streams in the Interior Plateau Ecoregion.

Percentile Score	**>90% 5**	**70-90% 4**	**40-70% 3**	**20-40% 2**	**<20% 1**
TR	≥40	30--39	20--29	10—19	≤9
EPT	≥13	7--12	4--6	2—3	≤1
HBI	≤4.2	4.3--6.0	6.10--7.2	7.3--7.8	≥7.9
PCD-5	≤65	64--72	71--80	81—92	≥93
%EPT	≥55	26--54	7--25	2—6	≤1

MBI scores for first and second order streams of the Interior Plateau Ecoregion.

Percentile Classification	**>95% Excellent**	**70-95% Good**	**40-70% Fair**	**20-40% Poor**	**<20% Very Poor**
Score	21--25	18--20	14--17	9—13	≤8

Metric criteria derived from percentiles of third and fourth order streams in the Interior Plateau Ecoregion.

Percentile Score	**>90% 5**	**70-90% 4**	**40-70% 3**	**20-40% 2**	**<20% 1**
TR	≥63	55--62	40--51	29--39	≤19
EPT	≥19	14--18	10--13	7--9	<7
HBI	≤5.2	5.3--5.6	5.7--6.1	6.2--6.8	>6.8
PCD-5	≤45	46--54	55--64	65--73	>73
%EPT	≥61	50--60	38--49	23--37	≤22

MBI scores for third and fourth order streams of the Interior Plateau Ecoregion.

Percentile Classification	**>95% Excellent**	**70-95% Good**	**40-70% Fair**	**20-40% Poor**	**<20% Very Poor**
Score	21--25	17--20	14--16	10--13	≤9

PROTOCOL - STREAM/HABITAT ASSESSMENT

1.0 What

As part of the LFUCG's Stormwater Quality Management Program, Tt will collect information pertaining to the physical and biological characteristics of the stream sections in which fish and macroinvertebrate sampling has been conducted.

2.0 Why

A habitat assessment based on US EPA methodology (Barbour *et al.* 1999) will be used to provide an empirical, semi-quantified evaluation of the general lotic macrohabitat. Available habitat quality and quantity influence the structure and composition of resident aquatic communities; therefore, this information will be an integral part of the biological data interpretation.

3.0 When

Habitat assessments will be conducted once per year during the macroinvertebrate sampling effort. If during the fish sampling effort the habitat appears to have changed, it will be reassessed.

4.0 Where

Ten stations will be surveyed. The locations for habitat assessment are as follows:

CR-S3	EH-S7	NE-S4	TB-S1
TB-S2	TB-S3	SE-S1	WH-S0
WR-S1	WR-S2		

5.0 Who

The sampling crew will consist of biologists from TRC. Sampling will be coordinated by Jennifer Arnold (Tt) and Gerry Fister (TRC).

6.0 How

Visual inspections of instream habitat, substrate quality, channel morphology, bank structural features, and riparian vegetation will be made and recorded for each sampling reach. A total of 10 habitat parameters are rated as optimal (16 to 20), suboptimal (11 to 15), marginal (6 to 10), or poor (0 to 5) based on criteria included on the Habitat Assessment Field Data Sheet. Habitat assessment scores for each station are obtained by adding the 10 parameter scores as recorded on each habitat sheet. Scoring ranges for the 10 habitat parameter are 0 to 20, so the best possible score for each station is 200. For streams of the Interior Plateau Physiographic Province, a habitat score below 78 indicates non-support for the designated use of Aquatic Life (Warmwater Aquatic Habitat)

(KDOW 2000). Scores between 78 and 116 indicate support but are considered threatened. Scores above 116 indicate full support of designated uses.

The final habitat site score is determined by summing all of the individual parameter scores (the maximum possible site score is 200).

Parameter 1: Epifaunal Substrate/Available Cover

Includes the relative quantity and variety of natural structures in the stream, such as cobble (riffles), large rocks, fallen trees, logs and branches, and undercut banks, available as refugia, feeding, or sites for spawning and nursery functions of aquatic macrofauna. A wide variety and/or abundance of submerged structures in the stream provides macroinvertebrates and fish with a large number of niches, thus increasing habitat diversity. As variety and abundance of cover decreases, habitat structures becomes monotonous, diversity decreases, and the potential for recovery following disturbance decreases. Riffles and runs are critical for maintaining a variety and abundance of insects in most high-gradient streams and serving as spawning and feeding refugia for certain fish. The extent and quality of the riffle is an important factor in the support of a healthy biological condition in high-gradient streams. Ruffles and runs offer a diversity of habitat through variety of particle size, and, in many small high-gradient streams, will provide the most stable habitat. Snags and submerged logs are among the most productive habitat structure for macroinvertebrate colonization and fish refugia in low-gradient streams. However, “new fall” will not yet be suitable for colonization.

Parameter 2a: Embeddedness

Refers to the extent to which rocks (gravel, cobble, and boulders) and snags are covered or sunken into the silt, sand, or mud of the stream bottom. Generally, as rocks become embedded, the surface area available to macroinvertebrates and fish (shelter, spawning, and egg incubation) is decreased. Embeddedness is a result of large-scale sediment movement and deposition, and is a parameter evaluated in the riffles and runs of high-gradient streams. The rating of this parameter may be variable depending on where the observations are taken. To avoid confusion with sediment deposition (another habitat parameter), observations of embeddedness should be taken in the upstream and central portions of riffles and cobble substrate areas.

Parameter 2b: Pool Substrate Characterization

Evaluates the type and condition of bottom substrates found in pools. Firmer sediment types (e.g., gravel, sand) and rooted aquatic plants support a wider variety of organisms than a pool substrate dominated by mud or bedrock and no plants. In addition, a stream that has a uniform substrate in its pools will support far fewer types of organisms than a stream that has a variety of substrate types.

Parameter 3a: Velocity/Depth Combinations

Patterns of velocity and depth are included for high-gradient streams under this parameter as an important feature of habitat diversity. The best streams in most high-gradient regions will have all 4 patterns present: (1) slow-deep, (2) slow-shallow, (3) fast-deep, and (4) fast-shallow. The general guidelines are 0.5 m depth to separate shallow from deep, and 0.3 m/sec to separate fast from slow. The occurrence of these 4 patterns relates to the stream's ability to provide and maintain a stable aquatic environment.

Parameter 3b: Pool Variability

Rates the overall mixture of pool types found in streams, according to size and depth. The 4 basic types of pools are large-shallow, large-deep, small-shallow, and small-deep. A stream with many pool types will support a wide variety of aquatic species. Rivers with low sinuosity (few bends) and monotonous pool characteristics do not have sufficient quantities and types of habitat to support a diverse aquatic community. General guidelines are any pool dimension (i.e., length, width, oblique) greater than half the cross-section of the stream for separating large from small and 1 m depth separating shallow and deep.

Parameter 4: Sediment Deposition

Measures the amount of sediment that has accumulated in pools and the changes that have occurred to the stream bottom as a result of deposition. Deposition occurs from large-scale movement of sediment. Sediment deposition may cause the formation of islands, point bars (areas of increased deposition usually at the beginning of a meander that increase in size as the channel is diverted toward the outer bank) or shoals, or result in the filling of runs and pools. Usually deposition is evident in areas that are obstructed by natural or manmade debris and areas where the stream flow decreases, such as bends. High levels of sediment deposition are symptoms of an unstable and continually changing environment that becomes unsuitable for many organisms.

Parameter 5: Channel Flow Status

The degree to which the channel is filled with water. The flow status will change as the channel enlarges (e.g., aggrading stream beds with actively widening channels) or as flow decreases as a result of dams and other obstructions, diversions for irrigation, or drought. When water does not cover much of the streambed, the amount of suitable substrate for aquatic organisms is limited. In high-gradient streams, riffles and cobble substrate are exposed; in low-gradient streams, the decrease in water level exposes logs and snags, thereby reducing the areas of good habitat. Channel flow is especially useful for interpreting biological condition under abnormal or lowered flow conditions. This parameter becomes important when more than one biological index period is used for surveys or the timing of sampling is inconsistent among sites or annual periodicity.

Parameter 6: Channel Alteration

Is a measure of large-scale changes in the shape of the stream channel. Many streams in urban and agricultural areas have been straightened, deepened, or diverted into concrete channels, often for flood control or irrigation purposes. Such streams have far fewer natural habitats for fish, macroinvertebrates, and plants than do naturally meandering streams. Channel alteration is present when artificial embankments, riprap, and other forms of artificial bank stabilization or structures are present; when the stream is very straight for significant distances; when dams and bridges are present; and when other such changes have occurred. Scouring is often associated with channel alteration.

Parameter 7a: Frequency of Riffles (or Bends)

Is a way to measure the sequence of riffles and thus the heterogeneity occurring in a stream. Riffles are a source of high-quality habitat and diverse fauna, therefore, an increased frequency of occurrence greatly enhances the diversity of the stream community. For high gradient streams where distinct riffles are uncommon, a run/bend ratio can be used as a measure of meandering or sinuosity (see 7b). A high degree of sinuosity provides for diverse habitat and fauna, and the stream is better able to handle surges when the stream fluctuates as a result of storms. The absorption of this energy by bends protects the stream from excessive erosion and flooding and provides refugia for benthic invertebrates and fish during storm events. To gain an appreciation of this parameter in some streams, a longer segment or reach than that designated for sampling should be incorporated into the evaluation. In some situations, this parameter may be rated from viewing accurate topographical maps. The "sequencing" pattern of the stream morphology is important in rating this parameter. In headwaters, riffles are usually continuous and the presence of cascades or boulders provides a form of sinuosity and enhances the structure of the stream. A stable channel is one that does not exhibit progressive changes in slope, shape, or dimensions, although short-term variations may occur during floods (Gordon *et al.* 1992).

Parameter 7b: Channel Sinuosity

Evaluates the meadering or sinuosity of the stream. A high degree of sinuosity provides for diverse habitat and fauna, and the stream is better able to handle surges when the stream fluctuates as a result of storms. The absorption of this energy by bends protects the stream from excessive erosion and flooding and provides refugia for benthic invertebrates and fish during storm events. To gain an appreciation of this parameter in low gradient streams, a longer segment or reach than that designated for sampling may be incorporated into the evaluation. In some situations, this parameter may be rated from viewing accurate topographical maps. The "sequencing" pattern of the stream morphology is important in rating this parameter. In "oxbow" streams of coastal areas and deltas, meanders are highly exaggerated and transient. Natural conditions in these streams are shifting channels and bends, and alteration is usually in the form of flow regulation and diversion. A stable channel is one that does not exhibit progressive changes in slope, shape, or dimensions, although short-term variations may occur during floods (Gordon *et al.* 1992).

Parameter 8: Bank Stability (condition of banks)

Measures whether the stream banks are eroded (or have the potential for erosion). Steep banks are more likely to collapse and suffer from erosion than are gently sloping banks, and are therefore considered to be unstable. Signs of erosion include crumbling, unvegetated banks, exposed tree roots, and exposed soil. Eroded banks indicate a problem of sediment movement and deposition, and suggest a scarcity of cover and organic input to streams. Each bank is evaluated separately and the cumulative score (right and left) is used for this parameter.

Parameter 9: Bank Vegetative Protection

Measures the amount of vegetative protection afforded to the stream bank and the near-stream portion of the riparian zone. The root systems of plants growing on stream banks help hold soil in place, thereby reducing the amount of erosion that is likely to occur. This parameter supplies information on the ability of the bank to resist erosion as well as some additional information on the update of nutrients by the plants, the control of instream scouring, and stream shading. Banks that have full, natural plant growth are better for fish and macroinvertebrates than are banks without vegetative protection or those shored up with concrete or riprap. This parameter is made more effective by defining the native vegetation for the region and stream type (i.e., shrubs, trees, etc.). In some regions, the introduction of exotics has virtually replaced all native vegetation. The value of exotic vegetation to the quality of the habitat structure and contribution to the stream ecosystem must be considered in this parameter. In areas of high grazing pressure from livestock or where residential and urban development activities disrupt the riparian zone, the growth of a natural plant community is impeded and can extend to the bank vegetative protection zone. Each bank is evaluated separately and the cumulative score (right and left) is used for this parameter.

Parameter 10: Riparian Vegetative Zone Width

Measures the width of natural vegetation from the edge of the stream bank out through the riparian zone. The vegetative zone serves as a buffer to pollutants entering a stream from runoff, controls erosion, and provides habitat and nutrient input into the stream. A relatively undisturbed riparian zone supports a robust stream system; narrow riparian zones occur when roads, parking lots, fields, lawns, bare soil, rocks, or buildings are near the stream bank. Residential developments, urban centers, golf courses, and rangeland are the common causes of anthropogenic degradation of the riparian zone. Conversely, the presence of “old field” (i.e., a previously developed field not currently in use), paths, and walkways in an otherwise undisturbed riparian zone may be judged to be inconsequential to altering the riparian zone and may be given relatively high scores. For variable size streams, the specified width of a desirable riparian zone may also be variable and may be best determined by some multiple of stream width (e.g., 4 x wetted stream width). Each bank is evaluated separately and the cumulative score (right and left) is used for this parameter.

HABITAT ASSESSMENT FIELD DATA SHEET — HIGH GRADIENT STEAMS (FRONT)[1]

STREAM NAME		LOCATION	
STATION #	RIVERMILE	COUNTY	STATE
LAT	LONG	RIVER BASIN	
CLIENT		PROJECT NO.	
INVESTIGATORS/CREW			
FORM COMPLETED BY	DATE_____ TIME _____ AM PM	REASON FOR SURVEY	

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Epifaunal Substrate/ Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient.	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (Slow is < 0.3 m/s, deep is > 0.5 m.)	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/depth regime (usually slow-deep).
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills > 75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

[1]Modified from EPA 841-B-99-002, *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish.*

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HABITAT ASSESSMENT FIELD DATA SHEET — HIGH GRADIENT STEAMS (BACK)[1]

Parameters to be evaluated in sampling reach

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream < 7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ration of > 25.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left or right side by facing downstream.	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. < 5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank)	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE ___ (LB)	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE ___ (RB)	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Total Score __________

[1]Modified from EPA 841-B-99-002, *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish.*

PROTOCOL - STREAM/WATER CHEMISTRY – DRY WEATHER MONITORING

1.0 What

As part of the LFUCG's Stormwater Quality Management Program, Tt will collect dry weather (non-storm) water samples to gather information on the chemical quality of the streams found within and around Fayette County.

2.0 Why

The results from collecting and analyzing these samples will provide information on the current water quality of the streams and will serve as a baseline when comparing water quality changes due to stormwater runoff. This data will also be used in long-term monitoring of stream water quality and as a supplement to biological data.

3.0 When

Streams will be sampled quarterly for dry weather water chemistry. The streams may be sampled after five days have elapsed without more than 1” of rain.

4.0 Where

Ten stations will be sampled. The locations for dry weather chemistry are as follows:

CR-S3	EH-S7	NE-S4	TB-S1
TB-S2	TB-S3	SE-S1	WH-S0
WR-S1	WR-S2		

5.0 Who

The sampling crew will consist of environmental technicians and scientists. Sampling will be coordinated by Jennifer Arnold (Tt).

6.0 How

The following list details the method for dry weather sample collection from streams.

6.1 Once Lexington is in a period of five days without more than 1” of rain and the streams are at or near base flow, secure a vehicle, gather the necessary supplies, notify that lab that you plan to bring them samples (so they can be prepared for bacteriologicals) and head to the designated sampling locations. Supplies needed include: a bailer, coolers with sampling containers and a COC, ice packs, data sheets, a Sharpie pen, an ink pen or pencil, the Hanna and YSI water quality instruments, a portable suction filter, filters, the velocity probe, and waders.

6.2 When you collect the grab sample record pH, temperature, dissolved oxygen, specific conductance, flow, weather conditions, and time of collection. Label the sample bottles immediately upon collection and put them in the cooler with ice.

To collect samples: Prior to collecting the samples, rinse the bailer instream. Always fill the bailer with the bailer opening facing upstream. Avoid contacting bottom sediments and floating debris and touching the inside of the bailer. Fill the bailer with stream water from the main flow, well-mixed portion of the channel, pour from the bailer to the prelabeled containers (not fecals or dissolved phosphorous), seal the prelabeled containers with screw top lids, and dump any remaining water in the bailer downstream of the sampling point. To collect fecal coliform and strep samples, fill these containers directly from the main flow, well-mixed portion of the channel without using the bailer. The dissolved phosphorous sample will be filtered in the field.

Measure the flow by determining the depth within the established cross-section and measuring the average velocity.

6.3 Take your coolers of samples to Microbac. Make sure you fill out the chain-of-custody sheet (COC) and make a photocopy of it once it is completed. Microbac will analyze the samples for the following parameters.

Ammonia
Nitrate + Nitrite
Total Kjeldahl Nitrogen (TKN)
Total Phosphorus
Dissolved Phosphorus
Orthophosphate
Total Organic Carbon (TOC)
Biological Oxygen Demand, 5-day/Carbonaceous (BOD, 5-day/C)
Chemical Oxygen Demand (COD)
Total Suspended Solids (TSS)
Total Dissolved Solids (TDS)
Oil & Grease, Total
Oil & Grease, Hydrocarbon
Phenols
Fecal Coliform (FC)
Fecal Strep (FS)
FC/FS ratio
Total Coliform (TC)
Turbidity
Hardness, Total
Total Recoverable Cadmium
Total Recoverable Copper
Total Recoverable Lead
Total Recoverable Zinc
pH

6.4 After you have finished in the lab, clean your equipment and return it to its storage location. Document any problems you encounter and give this along with your field notes and the copy of the COC to the sampling coordinator.

PROTOCOL - STREAM/SEDIMENT

1.0 What

As part of the LFUCG's Stormwater Quality Management Program, Tt will collect sediment samples to gather information on the chemical quality of the stream sediment found within Fayette County.

2.0 Why

The results from collecting and analyzing these samples will provide information on the current sediment quality of the streams. This data will also be used in long-term monitoring of stream sediment quality and as a supplement to biological data.

3.0 When

Stream sediment samples will be collected once every two years as part of the industrial facility in-stream sampling program. To ensure the validity of the sample and to allow adequate time for fresh sediment to deposit, sediment samples will be collected only if five consecutive days have elapsed without a rain event and if there is no flow in the wet-weather tributaries.

4.0 Where

Ten stations will be sampled. The locations for dry weather chemistry are as follows:

CR-S3	EH-S7	NE-S4	TB-S1
TB-S2	TB-S3	SE-S1	WH-S0
WR-S1	WR-S2		

5.0 Who

The sampling crew will consist of environmental technicians and scientists. Sampling will be coordinated by Jennifer Arnold (Tt).

6.0 How

The following list details the method for sediment sample collection from streams.

6.1 Prior to sampling, clean all non-disposable collection equipment as follows: wash with mild detergent, rinse with distilled water, rinse with 5% by volume trace element-free hydrochloric acid, rinse with acetone. Allow equipment to air dry and then store the equipment in a plastic food-storage container.

6.2 Gather the following equipment before going to collect samples: disposable Teflon spoons or scoops, a 2.0 mm stainless steel 3-inch diameter sieve, a 63 µm nylon mesh sieve cloth (one per site), 8-inch plastic sieve frame, 8-inch diameter top-3/4-inch diameter stem plastic funnel, Teflon policeman or spatula, 500-mL plastic wash bottle, powder free latex disposable gloves, pre-cleaned borosilicate glass freezer jars with Teflon-lined lids, distilled water, 5% by volume trace element-free hydrochloric acid, acetone, ultra-pure deionized water, and a flat bottom 5-L glass bowl.

6.3 Prior to collecting the first sample, rinse all sampling equipment with stream water and rinse all sampling containers with ultra-pure deionized water. To avoid cross-contamination of samples, rinse the non-disposable sampling equipment with distilled water, 5% by volume trace element-free hydrochloric acid, acetone, and stream water between each use.

6.4 The sediment sample should be collected before any other field activities are started to reduce the amount of sediment disturbance.

Stream sediment samples are a composite of at least three depositional areas along or near the desired cross-section. Good sediment depositional areas include the inside bend of a stream; areas downstream of obstacles such as boulders, islands, and sand bars; areas of flow reversal; and shallow waters near the shore. Avoid bank-side deposits, sites located immediately upstream or downstream from a confluence of two streams, and sites downstream of a bridge, bridge pier, or debris.

To collect the sediment samples accessible by wading, approach the sampling location from downstream. Put on latex gloves. From each depositional area collect 5 to 10 sub-samples of the top 1-2 cm of recently deposited material by scooping in an upstream direction and taking care not to lose any fines as you bring the sample up to the surface. Place the sub-samples in the glass bowl. Once the three depositional areas have been sampled, mix all of the sub-samples in the glass bowl to a slurry by stirring (with the Teflon scoop or spoon) in a circular fashion, reversing direction, and occasionally turning the material over.

Transfer the mixture to the jars labeled for particle size analysis and tighten the Teflon-lined lid. The remaining mixture will be sieved in two halves. To sieve for trace elements stretch the 63 μm mesh nylon sieve cloth over the plastic sieve frame and attach the retaining ring. Assemble in series the 63 μm mesh nylon sieve and frame over the plastic funnel over the collection container. Place a small amount of composite sample onto the mesh sieve with the Teflon spatula. Pressure sieve the sample using native water collected in the 500-mL plastic wash bottle. The fine sediments pass through the sieve with a stream of water and with aggressive shaking of the sieve. Work small amounts of fine sediment through the sieve at a time and discard any material that remains on the sieve. If additional wash water is needed, allow the sieved sediment/native water to settle several minutes and decant only the native water back into the wash bottle for reuse. Continue to reuse the native water until the necessary sample is obtained. To sieve for organic contaminants place the 2.0 mm stainless steel sieve over the collection jar. Gently work a small portion of the divided sample through the sieve with a Teflon policeman or spatula. Do not use water. The bottom of the sieve may require periodic removal of the material that adheres to it. Once sieving is complete, label the jars and place them on ice. In the log book, prepare a sketch showing where the collection areas are located for each composite sample. Also, record the weather conditions.

6.5 Take your coolers of samples to Microbac. Make sure you fill out the chain-of-custody sheet (COC) and make a photocopy of it. The laboratory will analyze the samples for the following parameters. Next to each parameter is a 63 if it will be tested from the 63 μm sieving or a 2.0 if it will be tested from the 2.0 mm sieving. If no number is indicated, then it will be sieved in the laboratory. Lab analysts should see the attached copy of "Lab Guidance for Stream Sediment Samples" before beginning any laboratory work. Attach a copy of this guidance document to the COC.

TKN 2.0	Total Arsenic 63
TPH 2.0	Total Cadmium 63
Diazinon by Elisa 2.0	Total Chromium 63
PCBs 2.0	Total Copper 63
Total Phosphorus 2.0	Total Lead 63
Total Cyanide 2.0	Total Mercury 63
Pesticides 2.0	Total Nickel 63
pH 2.0	Total Zinc 63
Chlordane 2.0	% Total Solids 63
Herbicides (3) 2.0	
% Total Solids 2.0	Particle Size

In conjunction with each analysis, a sediment sample should be analyzed for percent moisture, or total solids; all results should be reported on a total solids (dry weight) basis.

6.6 After you have finished in the lab, clean your equipment and return it to its storage location. Document any problems you encounter and give this along with your field notes and the copy of the COC to the sampling coordinator.

LABORATORY GUIDANCE FOR STREAM SEDIMENT SAMPLES

Sample handling and analysis procedures for LFUCG stream sediment samples:

The following procedures should be followed when dealing with any **stream sediment** sample submitted by Tt pertaining to Project #04168.

During field collection, we will sieve portions of the sample using 2.0 mm and 63 μm sieves. Our 63 μm sieving procedure includes use of stream water (to wash particles through the mesh) so that samples collected are a mixture of sediment and water.

Decanting

Before any analysis is conducted, the samples should be allowed to settle completely. After the liquid portion of the sample is clear (no suspended sediment), the liquid portion should be carefully siphoned off (using a syringe or gentle peristaltic pump) as much as possible and discarded without disturbing any of the underlying sediment. If a holding time will be exceeded due to the liquid portion still being turbid, the sample should be centrifuged and the supernatant decanted off and discarded. Conduct all analysis on the **sediment** portion of the sample. No analysis should ever be conducted on the liquid portion of the sample. In conjunction with each analysis (the 2.0 mm parameters and the 63 μm parameters), the sediment sample should be analyzed for percent moisture, or total solids and all results should be reported on a total solids (dry weight) basis.

The following is a complete list of test parameters to be run; in parenthesis are the sieve mesh sizes (as recommended by KY Division of Water):

Total Phosphorus (2.0 mm)
pH (2.0 mm) of paste
TKN (2.0 mm)
Total Cyanide (2.0 mm)
TPH (2.0 mm)
Diazinon by Elisa, elutriate (2.0 mm)
Pesticides (w/Chlordane) (2.0 mm)
Herbicides (3) (2.0 mm)
PCBs (2.0 mm)
% Total Solids (2.0 mm)

Total Copper (63 μm)
Total Arsenic (63 μm)
Total Mercury (63 μm)
Total Cadmium (63 μm)
Total Chromium (63 μm)
Total Zinc (63 μm)
Total Nickel (63 μm)
Total Lead (63 μm)
% Total Solids (63 μm)
Particle Size

METALS:

After the liquid portion of the sample has been decanted, homogenize the sample thoroughly before conducting the analysis. The extraction method that should be used for all metals except Hg is SW 846-3050; for Hg, use SW 846-7471.

PESTICIDES/HERBICIDES/SEMIVOLS/OTHER

All other samples (2.0 mm parameters) should be handled in terms of the decanting method outlined above. Pesticides should be extracted using method SW 846-3540. All other analysis should be conducted using **soil** analysis methods.

PROTOCOL - STREAM/WATER CHEMISTRY - STORM EVENTS

1.0 What

As part of the LFUCG's Stormwater Quality Management Program, Tt will collect storm event water samples to gather information on the chemical quality of the streams found within and around Fayette County.

2.0 Why

The results from collecting and analyzing storm event samples will provide information on the current impact of stormwater runoff on instream water quality. This data will also be used in long-term monitoring of stream water quality and quantity and to compute pollutant loadings.

3.0 When

Stream storm samples will be collected quarterly at each site.

In order for a storm event to be eligible for sample collection, it must be preceded by at least 72 hours of dry weather (less than 0.1 inches of rainfall) and have a total rainfall accumulation that will cause the flow in the stream to be greater than base flow. Ideally, the depth of rain and the duration of the event should not vary by more than 50 percent from the average depth and duration; however, it is necessary to ensure that the amount of rainfall will be adequate to cause a response in the streams.

4.0 Where

Ten stations will be sampled. The locations for storm event chemistry are as follows:

CR-S3	EH-S7	NE-S4	TB-S1
TB-S2	TB-S3	SE-S1	WH-S0
WR-S1	WR-S2		

5.0 Who

The sampling crew will primarily consist of Shann Easterling, Brent Perry, and Jessie Wilder. Sampling will be coordinated by Jennifer Arnold (Tt).

6.0 How

The following list details the method for stormwater sample collection from streams.

6.1 Sampling stations will be set to the active monitoring status when weather forecasts indicate a very good chance for rain and after 72 hours of dry weather, defined as a time period with a total rainfall accumulation of less than 0.1 inch.

6.2 During active monitoring periods, sampling stations will be configured to receive and store data, collect samples, and transmit conditions. All water-quality monitoring devices will be calibrated and may be installed in the stream to receive data. Water-quality monitoring devices may track the stream's pH, DO, conductivity, and temperature. Tt personnel will place clean bottles in the sampler before sampling begins.

For guidance on how to configure the samplers and flow meters see "ISCO and AMERICAN SIGMA SAMPLER PROTOCOLS" at the end of this section.

6.3 Tt will program set conditions in the flowmeter or sampler module. Set conditions consist of certain levels of rain, changes in base flow, or changes in pH, DO, conductivity, or temperature created by a storm situation. Set condition levels shall be site specific and determined from past results and by the amount and type of land drained. Tt may override the set conditions at any time during or before an event to make changes in the sampling program.

6.4 American Sigma sampler can hold and refrigerate eight 1.9-L bottles. Isco samplers can hold twelve 1-L bottles. The flow meter will pace the sampler throughout the sampling period until all bottles are filled. Flow conditions will be monitored through compatible software. The sampler pacing will be reduced or increased if the runoff appears to be 25 percent greater than or less than average storm flow.

6.5 The Microbac Project Manager, and Microbac's microbiological staff in the project manager's absence, will be contacted if Tt plans to collect samples. Refrigerated or iced samplers are used to preserve samples until they can be picked up to turn in to the lab. A Chain of Custody (COC) will be completed to be turned in with each sample. It should be noted on the COC that Microbac is to save the bottles and lids for Tt to pick up and clean.

The following matrix will aid in decision-making for events with limited sample volume.

LFUCG
Parameter Matrix for Storm Sampling Decision-Making

Parameter	Sample Volume Required	Holding Time	Cost of Analysis	Required by	Possible Sources (Occurs in . . .)
Fecal Coliform	100mL	6 h	25.00	PA	Animal waste; Human sewage
Fecal Strep		48 h		PA	
Total Coliform – MF	100 mL	30 h	11.00	PA	
TSS	32 oz (946 mL)	7 d	11.00	PA, SOW	Nature
TDS		7 d	11.00	SOW	
Turbidity		48 h	10.00	PA	
pH		Immediate	5.00		
TOC	8 oz (236 mL)	28 d	32.00	PA	
Nitrate + Nitrite	8 oz (236 mL)	28 d	22.00	PA, SOW	Nature, Fertilizer, Sewage, etc.
Ammonia	250 mL	28 d	12.00	PA	
TKN		28 d	26.00	PA, SOW	
Orthophosphate		48 hour	12.00	TMDL	
Total Phosphorus		28 d	24.00	PA, SOW	
COD		28 d	18.00	PA, SOW	Industrial discharge
Dissolved Phosphorus	8 oz (236 mL)	14 d	24.00	PA, SOW	Nature, Fertilizer, Sewage, etc.
O&G, Hydrocarbon	1000 mL	28 d	50.00	PA	Oil, Gasoline, Diesel
O&G, Total		28 d		PA	
Phenols, Total	4 oz (118 mL)	28 d	24.00	PA	Coal tar, Detergents, Pavement
Diazinon	8 oz (236 mL)	28 d	35.00	PA	Pesiticide
BOD-5d/C	32 oz (946 mL)	48 h	18.00	PA, SOW	Nature, sewage, etc.
Hardness, Total	8 oz (236 mL)	6 m	12.00		Need this to determine acute criteria limits for metals
Total Recoverable Cd	8 oz (236 mL)	6 m	12.00	SOW	Batteries, Paints, Plastics
Total Recoverable Cu		6 m	12.00	PA, SOW	Pipes, Paint, Metal, Brakes
Total Recoverable Pb		6 m	12.00	PA, SOW	Gasoline, Paint, Pipes
Total Recoverable Zn		6 m	12.00	PA, SOW	Galvanized Metal
Total:	4876 mL		430.00		

PA = KPDES Permit Application
SOW = Scope of Work
TMDL = Will aid in TMDL determination; request of Lindell Ormsbee

6.6 Microbac will combine the sample bottles as indicated to produce three hydrograph samples (rise, peak, and fall). Once the samples are poured from the sampler bottles, Microbac will hold the sampler bottles and lids for Tt to pick-up. This directive needs to be included on the COC. The following parameters will be analyzed for each hydrograph sample:

Ammonia
Nitrate + Nitrite
Total Kjeldahl Nitrogen (TKN)
Total Phosphorus
Dissolved Phosphorus
Orthophosphate
Total Organic Carbon (TOC)
Biological Oxygen Demand, 5-day/Carbonaceous (BOD, 5-day/C)
Chemical Oxygen Demand (COD)
Total Suspended Solids (TSS)
Total Dissolved Solids (TDS)
Oil & Grease, Total
Oil & Grease, Hydrocarbon
Phenols
Fecal Coliform (FC)
Fecal Strep (FS)
FC/FS ratio
Total Coliform (TC)
Turbidity
Hardness, Total
pH
Total Recoverable Cadmium
Total Recoverable Copper
Total Recoverable Lead
Total Recoverable Zinc

6.7 If any sampler data was collected on a lap-top computer, those files will be copied to the network so that they will be available for retrieval and inclusion in the year-end report. Tt staff will clean and sterilize bottles for future use.

ISCO and AMERICAN SIGMA SAMPLER PROTOCOLS

ISCO 6700 Sampler with an ISCO Area Velocity (AV) Flow Meter

1. Install the AV probe in pipe or stream channel facing up stream using a metal plate attached to a cinder block or the inside of the pipe and connect to an ISCO AV Flow Meter.

2. Install the sampler tubing in the pipe or stream channel making sure the strainer is downstream of the AV probe.

3. Connect the flow meter to the sampler with the cable.

4. Power Supply: If using a JOBOX, power can be supplied by a car battery connected to the Sampler (the Flow Meter will get power through its connection to the Sampler). If a JOBOX is not used, portable ISCO rechargeable batteries should be connected to both the Sampler and the Flow Meter.

5. Programming the Flow Meter: (**Note: The Flow Meter should always be programmed first)**. Main screen on AV Flow Meter shows daily flow totals, current flow, level, date and time. When presented with multiple choices, pick the flashing item represented with **BOLD** print in this document. If none of the answers are **BOLD**, the answer is site specific. Press **ENTER** to advance to the next menu screen.

    - Press **ENTER/PROGRAM STEP**

    - Select Option
      PROGRAM – SETUP ← choose PROGRAM and press ENTER

    - Level Units of Measure
      FT – **IN** – M – MM – NOT MEASURED

    - Flow Rate Units of Measure
      GPS – GPM – GPH – MGD – **CFS** – CFM – → arrow in menu indicates more choices

    - Totalized Volume Units
      GAL – **MGAL** – CF – L – M3 – AF

    - Velocity Units of Measure
      FT/S – M/S – NOT MEASURED

    - Rainfall Units of Measure
      IN – MM – NOT MEASURED ← If raingage is attached, else not measured

5. Programming the Flow Meter (cont'd)

- PH Units of Measure
  PH – **NOT MEASURED**

- DO Units of Measure
  MG/L – **NOT MEASURED**

- Temp Units of Measure
  F – C – **NOT MEASURED**

- YSI 600 Connected
  YES – **NO**

- Flow Calculation
  AREA VELOCITY – LEVEL TO FLOW RATE

- Area Velocity Calculation
  CHANNEL SHAPE – DATA POINTS

- Area Velocity Channel Shape
  ROUND PIPE – U-CHANNEL – RECTANGULAR – TRAPEZOIDAL

- Maximum Head
  ___ ← Enter max head for site…use 6.0 inches if unsure

- Calculate Flow at Maximum Head
  ___ ← Flow Meter calculates, returns flow at max head, press ENTER

- Parameter to adjust
  NONE – **LEVEL** ← select LEVEL to calibrate current level reading

- Reset Flow Totalizer
  YES – NO ← yes if new installation, no otherwise.

- Enable Totalizer
  ENTER

- Reset Sampler Enable Totalizer
  YES – **NO**

- Sampler Pacing
  DISABLE – VOLUME – CONDITIONAL

- Sampler Enable Mode
  ENABLE – DISABLE – **CONDITIONAL**

5. Programming the Flow Meter (cont'd)

- Condition
  LEVEL – VELOCITY – FLOW RATE

- Level
  GREATER THAN – LESS THAN – RATE OF CHANGE

- Level
  GREATER THAN ____ ← enter appropriate value for site

- Operator
  OR – AND – **DONE**

- When Enable Condition is No Longer Met
  DISABLE SAMPLER – **KEEP ENABLED**

- Enable Currently Latched, Reset? ← If this menu item does not appear,
  NO – **YES** latch already reset.

- Plotter On/Off with Enable
  YES – **NO**

- Alarm Dialout
  DISABLE – CONDITIONAL

- Plotter Speed
  OFF – ½"/hr – 1"/hr

- Report Generator A
  ON – **OFF**

- Report Generator B
  ON – **OFF**

- Print Flow Meter History
  YES – **NO**

- Clear History
  YES – NO ← yes if new installation, no otherwise

6. Programming the 6700 Sampler: (Note: The sampler should always be programmed last). When presented with multiple choices, pick the flashing item represented with **BOLD** print in this document. If none of the answers are **BOLD**, the answer is site specific. Press **ENTER** to advance to the next menu screen. Site "CR-L1" is used as an example in this document.

- Main Menu
  RUN "CR-L1" ← choose run if no changes are needed
  PROGRAM ← choose program for new setup or to alter parameters
  VIEW REPORT
  OTHER FUNCTIONS

- Program Name
  "CR-L1"
  Change?
  YES – NO ← change to match site name

- Site Description
  "Nandino Blvd."
  Change?
  YES – NO ← change to match location of site

- Select Units for length
  FT - M

- Data Storage Interval in Minutes
  1 – **2** – 5 – 10 – 15 – 20 ← 2 for land sites, 5 for stream sites

- Number of Bottles
  1 – 2 – 4 – 8 – **12** – 24

- Bottle Volume
  1000 ml

- Suction Line Length
  ___ ← enter length in feet

- **AUTO SUCTION HEAD**
  ENTER HEAD

- **1** RINSE CYCLE

6. Programming the Sampler (cont'd)

- RETRY UP TO **2** TIMES WHEN SAMPLING

- **ONE PART PROGRAM**
  TWO PART PROGRAM

- **UNIFORM TIMED PACED**
  FLOW PACED
  EVENT PACED
  NONUNIFORM TIMED PACED

- Time Between Sample Events
  0 HOURS, **12** MINUTES ← 12 for land sites, 15 for stream sites

- **1** BOTTLE PER SAMPLE EVENT

- Switch Bottles on:
  # OF SAMPLES
  TIME

- Switch Bottles Every:
  1 SAMPLES

- Run Continuously?
  YES – **NO**

- Do You Want Sample Volume Dependent on Flow?
  YES – **NO**

- Sample Volume
  950 ml

- Enable
  RAIN – **NONE**

- Once Enabled, Stay Enabled
  YES – NO

- Sample at Enable?
  YES – NO

- Pause Resume
  1. HH:MM DD HH:MM DD
  2. HH:MM DD HH:MM DD
  CLEAR **DONE**

6. Programming the Sampler (cont'd)

- **NO DELAY TO START**
  DELAYED START
  CLOCK TIME

- Programming Complete
  Run This Program Now?
  YES – NO

ISCO 6700 Sampler with an ISCO 730 Bubbler Flow Module

1. Install the sampler tubing in the pipe or stream channel.

2. Install the bubbler tubing so that the end remains fully submerged and at a constant depth.

3. Insert the 730 Bubbler Flow Module into the port on the side of the sampler console and connect the end of the bubbler tubing to the Module. Note: When using the 730 Bubbler Flow Module it is not necessary to have a Flow Meter.

4. Power Supply: If using a JOBOX, power can be supplied by a car battery connected to the Sampler. If a JOBOX is not used, there are solar panels and Pb-acid batteries that can be used which will last longer than the rechargeable Ni-Cad ISCO batteries.

5. Programming the 6700 Sampler with an attached 730 Bubbler Flow Module.

- Main Menu
  RUN "CR-L1" ← choose run if no changes are needed
  PROGRAM ← choose program for new setup or to alter parameters
  VIEW REPORT
  OTHER FUNCTIONS

- Program Name
  "CR-L1"
  Change?
  YES – NO ← change to match site name

- Site Description
  "Nandino Blvd."
  Change?
  YES – NO ← change to match location of site

- Select Units for length
  FT - M

- Data Storage Interval in Minutes
  1 – **2** – 5 – 10 – 15 – 20 ← 2 for land sites, 5 for stream sites

- Number of Bottles
  1 – 2 – 4 – 8 – **12** – 24

- Bottle Volume
  1000 ml

5. Programming the Sampler (cont'd)

- Suction Line Length
  ___ ← enter length in feet

- **AUTO SUCTION HEAD**
  ENTER HEAD

- **1** RINSE CYCLE

- RETRY UP TO **2** TIMES WHEN SAMPLING

- **ONE PART PROGRAM**
  TWO PART PROGRAM

- **UNIFORM TIMED PACED**
  FLOW PACED
  EVENT PACED
  NONUNIFORM TIMED PACED

- Time Between Sample Events
  0 HOURS, **12** MINUTES ← 12 for land sites, 15 for stream sites

- **1** BOTTLE PER SAMPLE EVENT

- Switch Bottles on:
  # OF SAMPLES
  TIME

- Switch Bottles Every:
  1 SAMPLES

- Run Continuously?
  YES – **NO**

- Do You Want Sample Volume Dependent on Flow?
  YES – **NO**

- Sample Volume
  950 ml

- Do You Want to Program the Module?
  YES – NO

- Set the Level
  ___ ← enter the level of stream at the bubbler tube.

5. Programming the Sampler (cont'd)

- Enable
  RAIN – **NONE**

- Once Enabled, Stay Enabled
  YES – NO

- Sample at Enable?
  YES – NO

Pause	Resume
1. HH:MM DD	HH:MM DD
2. HH:MM DD	HH:MM DD
CLEAR	**DONE**

- **NO DELAY TO START**
  DELAYED START
  CLOCK TIME

- Programming Complete
  Run This Program Now?
  YES – NO

American Sigma 900 MAX Refrigerated Sampler and 960 Flow Meter

1. Because these are permanent sampling sites, installation has been completed. If new sites are added, contact American Sigma or our local sales representative for guidance on installation. For maintenance issues refer to the *Operating & Maintenance Manual*.

2. Programming the 900 MAX Refrigerated Sampler. Choices below are menu items on the LCD unless indicated as being physical “soft key” buttons on the console. The correct choice for this procedure is indicated by **Bold** type.

   - **Main Menu** (soft key)
   - **Setup**
   - **Modify All Items**
   - Number of Bottles → **8**
   - Bottle Volume → **1900 ml**
   - Intake Tube Length → ___ (varies by site)
   - Intake Tube Type → **3/8” vinyl**
   - Program Lock → **disabled**
   - Program Delay → **disabled**
   - Sample Collection → **Time Proportional**
   - Intervals → **20 minutes**
   - Take First Sample → **Immediately**
   - Deliver Each Sample to All Bottles → **No**
   - Method of Distribution → **Samples/Bottle**
   - Samples per Bottle → **1**
   - Liquid Sensors → **enabled**
   - Sample Volume → **1850 ml**

2. Programming the 900 MAX Refrigerated Sampler (cont'd)

   - Intake Rinses → **1**
   - Sample Retries → **2**
   - Site ID → ___
   - Do you wish to access the advanced sampling features → **Yes**
   - **Setpoint Sampling**
   - Setpoint Sampling → **enabled**
   - Type of Control → **start on setpoint**
   - Input channel → **external control**
   - Delay when input becomes inactive → **0h 0m**
   - **Special Output**
   - Pin E, aux. connector special output → **enable**
   - When to turn on special output → **after each sample**
   - **Return to Main Menu**
   - **Run/Stop** (soft key)

3. Programming the 960 Flow Meter

   - **Main Menu**
   - **Setup**
   - **Modify All Items**
   - Flow Units → **cfs**
   - Level Units → **feet** (or inches, depending on location)
   - Primary Device → **head vs. flow**
   - Set Active Table → **return**

3. Programming the 960 Flow Meter (cont'd)

- Program Lock → **disabled**
- Sample Pacing → **disabled**
- Sample ID → **accept**
- Total Flow Units → **gal**
- **Options**
- **Advanced Options**
- **Setpoint Sampling**
- **High Level**
- High Level Setpoint Condition → **enabled**
- High Level Setpoint → "enter value – location dependent"
- High Level Deadband → "set to same as setpoint"
- **Run/Stop** (soft key)
- **Start from Beginning** (if first attempt)

ISCO, YSI, and American Sigma Contact Information

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